

**AMENDMENTS TO THE CLAIMS:**

This listing of the claims will replace all prior versions, and listings, of the claims in this application.

**Listing of Claims:**

1. (Original) A code division, multiple access (CDMA) receiver having an input node coupled to a plurality  $S$  of receive antennas that receive signals from a plurality  $N$  of transmit antennas, comprising:

$J$  correlators outputting soft symbol decisions, where  $J=N$  times a number of detected physical channels;

$N$  equalizers each having an input coupled to said input node and an output coupled to as many correlators as there are detected physical channels of the said  $J$  correlators;

a channel estimator having an input coupled to said input node and  $N$  outputs representing a channel estimate for each of said transmit antennas; and

a unit for computing coefficients for each of said  $N$  equalizers, said unit having a first input coupled to said input node, second inputs coupled to said  $N$  outputs of said channel estimator, and third inputs for receiving estimates of received chip energy per transmit antenna, said unit computing said coefficients so as to operate said equalizers for simultaneously suppressing inter-antenna interference and multiple user interference such that the suppression of the inter-antenna interference and the multiple user interference is balanced with respect to their deteriorating impact on symbol estimates.

2. (Original) A CDMA receiver as in claim 1, where said unit operates to compute

$$\mathbf{v}_n = \left[ \mathbf{R} + \sum_{m=1}^N (E_{d,m} G_d - E_{T,m}) \mathbf{p}_m \mathbf{p}_m^H \right]^{-1} \mathbf{p}_n,$$

where  $\mathbf{v}_n$  is a vector containing  $L$  filter coefficients for the equalizer assigned to transmit antenna  $n$ ,  $\mathbf{R}$  is an estimate of received signal covariance matrix averaged over a scrambling sequence,  $E_{d,m}$  is the received energy per chip for a physical channel from transmit antenna  $m$ ,  $G_d$  is the spreading factor for a physical channel,  $E_{T,m}$  is the total received energy per chip for the physical channel from the transmit antenna  $m$ ,  $(\cdot)^H$  is the Hermitean and  $\mathbf{p}_n$  is the channel impulse response for transmit antenna  $n$ , where vector  $\mathbf{p}_n$  contains the impulse response for all receive antennas.

3. (Original) A CDMA receiver as in claim 1, where said unit operates at a chip level.
4. (Original) A CDMA receiver as in claim 1, where said unit operates at a symbol level.
5. (Original) A CDMA receiver as in claim 1, where said unit updates said equalizer coefficients continuously using a least mean squares (LMS) or a recursive least squares (RLS) based algorithm.
6. (Original) A CDMA receiver as in claim 1, where adaptation of the equalizer coefficients is performed at a symbol rate at the output of a correlator bank
7. (Original) A CDMA receiver as in claim 1, where said unit updates said equalizer coefficients periodically at High Speed Downlink Packet Access (HSDPA) transmission time intervals (TTI).
8. (Original) A CDMA receiver as in claim 1, where said CDMA receiver comprises a Space Time Transmit Diversity (STTD) architecture receiver.
9. (Original) A CDMA receiver as in claim 1, where said CDMA receiver comprises a Double Space Time Transmit Diversity (STTD) architecture receiver.
10. (Original) A CDMA receiver as in claim 1, where said CDMA receiver performs equalization

at a symbol rate.

11. (Original) A CDMA receiver as in claim 1, where said CDMA receiver operates with one of orthogonal or non-orthogonal space-time codes.

12. (Original) A method to operate a code division, multiple access (CDMA) receiver that has an input node coupled to a plurality  $S$  of receive antennas that receive signals from a plurality  $N$  of transmit antennas,  $J$  correlators outputting soft symbol decisions, where  $J=N$  times a number of detected physical channels,  $N$  equalizers each having an input coupled to said input node and an output coupled to an associated one of said  $J$  correlators, comprising:

generating a channel estimate for each of said transmit antennas; and

determining coefficients for each of said  $N$  equalizers in accordance with signals appearing at said input node, said channel estimates, and estimates of received chip energy per transmit antenna, said coefficients operating said equalizers for simultaneously suppressing inter-antenna interference and multiple user interference so that the suppression of the inter-antenna interference and the multiple user interference is balanced with respect to their deteriorating impact on symbol estimates.

13. (Original) A method as in claim 12, where determining coefficients solves:

$$\mathbf{v}_n = \left[ \mathbf{R} + \sum_{m=1}^N (E_{d,m} G_d - E_{T,m}) \mathbf{p}_m \mathbf{p}_m^H \right]^{-1} \mathbf{p}_n,$$

where  $\mathbf{v}_n$  is a vector containing  $L$  filter coefficients for the equalizer assigned to transmit antenna  $n$ ,  $\mathbf{R}$  is an estimate of received signal covariance matrix averaged over a scrambling sequence,  $E_{d,m}$  is the received energy per chip for a physical channel from transmit antenna  $m$ ,  $G_d$  is the spreading factor for a physical channel,  $E_{T,m}$  is the total received energy per chip for the physical channel from the transmit antenna  $m$ ,  $( )^H$  is the Hermitean and  $\mathbf{p}_n$  is the channel impulse response for transmit antenna  $n$ , where vector  $\mathbf{p}_n$  contains the impulse response for all receive

antennas.

14. (Original) A method as in claim 12, where determining coefficients operates at a chip level.

15. (Original) A method as in claim 12, where determining coefficients operates at a symbol level.

16. (Original) A method as in claim 12, where determining coefficients updates said equalizer coefficients continuously using a least mean squares (LMS) or a recursive least squares (RLS) based algorithm.

17. (Original) A method as in claim 12, where determining coefficients occurs periodically at High Speed Downlink Packet Access (HSDPA) transmission time intervals (TTI).

18. (Original) A method as in claim 12, where said CDMA receiver comprises a Space Time Transmit Diversity (STTD) architecture receiver.

19. (Original) A method as in claim 12, where said CDMA receiver comprises a Double Space Time Transmit Diversity (STTD) architecture receiver.

20. (Original) A method as in claim 12, where said CDMA receiver performs equalization at a symbol rate.

21. (Original) A method as in claim 12, where the method operates with one of orthogonal or non-orthogonal space-time codes.

22. (Previously Presented) A receiver having an input node coupled to a plurality  $S$  of receive antennas that receive signals from a plurality  $N$  of transmit antennas, comprising:

$J$  correlator means for outputting soft symbol decisions, where  $J=N$  times a number of detected

physical channels;

$N$  equalizer means each having an input coupled to said input node and an output coupled to as many correlator means as there are detected physical channels of the said  $J$  correlator means;

channel estimator means having an input coupled to said input node and  $N$  outputs for representing a channel estimate for each of said transmit antennas; and

means for determining coefficients for each of said  $N$  equalizers, said determining means comprising a first input coupled to said input node, second inputs coupled to said  $N$  outputs of said channel estimator means, and third inputs for receiving estimates of received chip energy per transmit antenna, said determining means determining said coefficients so as to operate said equalizer means for simultaneously suppressing inter-antenna interference and multiple user interference such that the suppression of the inter-antenna interference and the multiple user interference is balanced with respect to their deteriorating impact on symbol estimates.

23. (Previously Presented) A receiver as in claim 22, where said determining means operates to compute

$$\mathbf{v}_n = \left[ \mathbf{R} + \sum_{m=1}^N (E_{d,m} G_d - E_{T,m}) \mathbf{p}_m \mathbf{p}_m^H \right]^{-1} \mathbf{p}_n,$$

where  $\mathbf{v}_n$  is a vector containing  $L$  filter coefficients for the equalizer means assigned to transmit antenna  $n$ ,  $\mathbf{R}$  is an estimate of received signal covariance matrix averaged over a scrambling sequence,  $E_{d,m}$  is the received energy per chip for a physical channel from transmit antenna  $m$ ,  $G_d$  is the spreading factor for a physical channel,  $E_{T,m}$  is the total received energy per chip for the physical channel from the transmit antenna  $m$ ,  $()^H$  is the Hermitean and  $\mathbf{p}_n$  is the channel impulse response for transmit antenna  $n$ , where vector  $\mathbf{p}_n$  contains the impulse response for all receive antennas.

24. (Previously Presented) A computer program product embodied on a computer readable

medium for directing a computer to operate with a code division, multiple access (CDMA) receiver that has an input node coupled to a plurality  $S$  of receive antennas that receive signals from a plurality  $N$  of transmit antennas,  $J$  correlators outputting soft symbol decisions, where  $J=N$  times a number of detected physical channels,  $N$  equalizers each having an input coupled to said input node and an output coupled to an associated one of said  $J$  correlators, comprising operations of:

generating a channel estimate for each of said transmit antennas; and

determining coefficients for each of said  $N$  equalizers in accordance with signals appearing at said input node, said channel estimates, and estimates of received chip energy per transmit antenna, said coefficients operating said equalizers for simultaneously suppressing inter-antenna interference and multiple user interference so that the suppression of the inter-antenna interference and the multiple user interference is balanced with respect to their deteriorating impact on symbol estimates.

25. (Previously Presented) A computer program product as in claim 24, where determining coefficients solves:

$$\mathbf{v}_n = \left[ \mathbf{R} + \sum_{m=1}^N (E_{d,m} G_d - E_{T,m}) \mathbf{p}_m \mathbf{p}_m^H \right]^{-1} \mathbf{p}_n,$$

where  $\mathbf{v}_n$  is a vector containing  $L$  filter coefficients for the equalizer assigned to transmit antenna  $n$ ,  $\mathbf{R}$  is an estimate of received signal covariance matrix averaged over a scrambling sequence,  $E_{d,m}$  is the received energy per chip for a physical channel from transmit antenna  $m$ ,  $G_d$  is the spreading factor for a physical channel,  $E_{T,m}$  is the total received energy per chip for the physical channel from the transmit antenna  $m$ ,  $( )^H$  is the Hermitean and  $\mathbf{p}_n$  is the channel impulse response for transmit antenna  $n$ , where vector  $\mathbf{p}_n$  contains the impulse response for all receive antennas.

26. (Previously Presented) A computer program product as in claim 24, where determining

coefficients operates at a chip level.

27. (Previously Presented) A computer program product as in claim 24, where determining coefficients operates at a symbol level.

28. (Previously Presented) A computer program product as in claim 24, where determining coefficients updates said equalizer coefficients continuously using a least mean squares (LMS) or a recursive least squares (RLS) based algorithm.

29. (Previously Presented) A computer program product as in claim 24, where determining coefficients occurs periodically at High Speed Downlink Packet Access (HSDPA) transmission time intervals (TTI).

30. (Previously Presented) A computer program product as in claim 24, where said CDMA receiver comprises a Space Time Transmit Diversity (STTD) architecture receiver.

31. (Previously Presented) A computer program product as in claim 24, where said CDMA receiver comprises a Double Space Time Transmit Diversity (STTD) architecture receiver.

32. (Previously Presented) A computer program product as in claim 24, where said CDMA receiver performs equalization at a symbol rate.

33. (Previously Presented) A computer program product as in claim 24, where the method operates with one of orthogonal or non-orthogonal space-time codes.

34. (New) A receiver, comprising:

an input configured to input signals from a plurality  $S$  of receive antennas that receive from a plurality  $N$  of transmit antennas;

$J$  correlator means for outputting soft symbol decisions, where  $J=N$  times a number of detected physical channels;

$N$  equalizer means each configured to input the signals and an output configured to provide outputs to as many of said correlator means as there are detected physical channels of said  $J$  correlator means;

channel estimator means comprising  $N$  outputs representing a channel estimate for each of said  $N$  transmit antennas; and

means for determining coefficients for each of said  $N$  equalizer means, said determining means having a first input configured to input the signals, a second input configured to input said  $N$  outputs of said channel estimator means, and a third input configured to input estimates of received energy per transmit antenna, said determining means configured to determine said coefficients so as to operate said  $N$  equalizer means for simultaneously suppressing inter-antenna interference and multiple user interference.

35. (New) A receiver as in claim 34, where said determining means determines said coefficients such that suppression of the inter-antenna interference and the multiple user interference is balanced with respect to their deteriorating impact on symbol estimates, and operates to determine

$$\mathbf{v}_n = \left[ \mathbf{R} + \sum_{m=1}^N (E_{d,m} G_d - E_{T,m}) \mathbf{p}_m \mathbf{p}_m^H \right]^{-1} \mathbf{p}_n,$$

where  $\mathbf{v}_n$  is a vector containing  $L$  filter coefficients for an equalizer means assigned to transmit antenna  $n$ ,  $\mathbf{R}$  is an estimate of received signal covariance matrix averaged over a scrambling sequence,  $E_{d,m}$  is received energy per chip for a physical channel from transmit antenna  $m$ ,  $G_d$  is a spreading factor for a physical channel,  $E_{T,m}$  is a total received energy per chip for the physical channel from the transmit antenna  $m$ ,  $()^H$  is the Hermitean and  $\mathbf{p}_n$  is a channel impulse response for transmit antenna  $n$ , where vector  $\mathbf{p}_n$  contains the impulse response for all receive antennas.



36. (New) A receiver as in claim 34, where said determining means operates at one of a chip level or a symbol level.

37. (New) A receiver as in claim 34, where said determining means is configured to update said equalizer coefficients continuously using a least mean squares (LMS) or a recursive least squares (RLS) procedure.

38. (New) A receiver as in claim 34, where adaptation of the equalizer coefficients is performed at a symbol rate.

39. (New) A receiver as in claim 34, where said determining means is configured to update said equalizer coefficients periodically at transmission time intervals.

40. (New) A receiver as in claim 34, where said receiver comprises one of a space time transmit diversity architecture receiver or a double space time transmit diversity architecture receiver.

41. (New) A receiver as in claim 34, where said receiver performs equalization at a symbol rate.

42. (New) A receiver as in claim 34, where said receiver operates with one of orthogonal or non-orthogonal space-time codes.

43. (New) A receiver as in claim 34, embodied at least partially in an integrated circuit.

44. (New) A receiver as in claim 34, embodied at least partially in a software executable by a data processor.

45. (New) A receiver as in claim 34, configured to operate in a code division multiple access system.

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46. (New) A receiver as in claim 34, configured to operate in a direct sequence code division multiple access system.

47. (New) A receiver as in claim 34, configured to operate in a wideband code division multiple access system.

48. (New) A receiver as in claim 34, configured to operate in a high speed downlink packet access system.